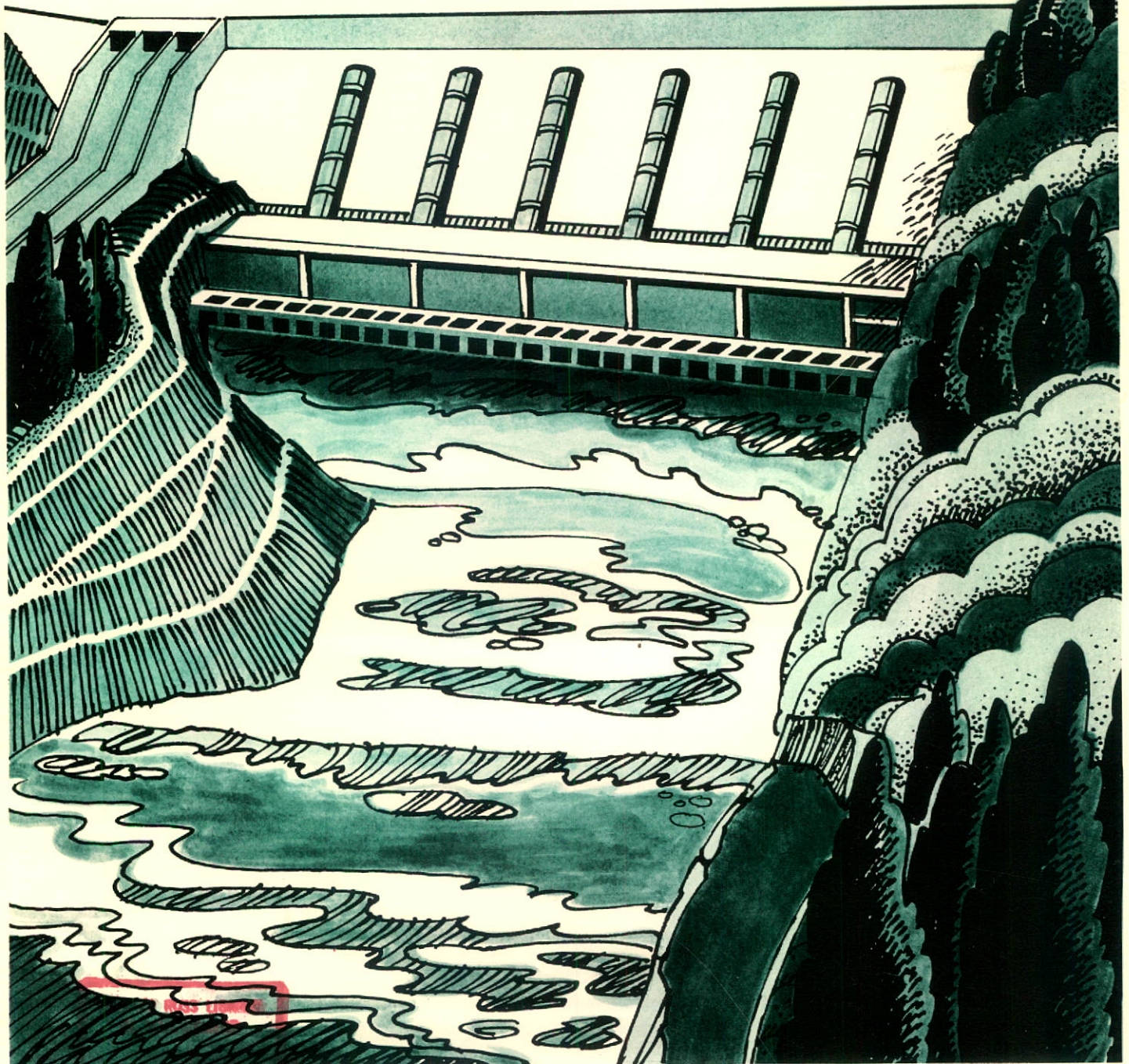


Power Perspectives

⊕ B.C. Hydro



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Introduction

It is the mandate of B.C. Hydro to meet the electricity needs of its British Columbian customers. It must meet these needs at the lowest long-term cost, while providing quality service and attaining the social, economic and environmental objectives of the government.

This booklet tells the story of electric system planning in British Columbia. It looks at the planning process and tells how future projects are studied, evaluated and selected. It also outlines how members of the public can have their say in the planning process.

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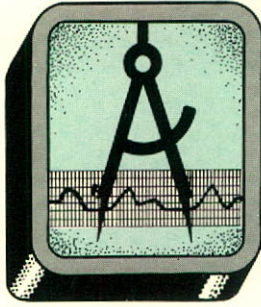
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The Planning Task

It takes many years to plan a new electrical development and bring it into production. For this reason, B.C. Hydro must always be looking ahead, examining potential sites and technologies to ensure that when the need arises for more electricity there will be a project at a sufficiently advanced stage to satisfy the need.

Hydro must maintain planning options at all times. The rate of growth of electric demand could change during the long planning process. An apparently acceptable project might on closer examination prove to be undesirable due to cost, environmental or other factors. A project also might be rejected at the licensing stage. Because of its responsibility to have electricity on line when British Columbians need it, Hydro must always have alternatives available in the event a preferred project is discarded for any reason.

This is why B.C. Hydro must concurrently study a number of potential electricity sources in various parts of the province. In 1981, for instance, studies at various stages are under way on the Murphy Creek site on the Columbia River, the Kootenay Diversion, the Hat Creek coal deposits, the Liard River, the Cutoff Mountain site on the Skeena River and the Stikine-Iskut river system. In addition, Hydro is looking at East Kootenay coal and is considering a new coal-burning technology. It also is exploring the possibilities of geothermal generation of electricity at Meager Creek and electric generation from wood wastes (hog fuel).

As Hydro conducts its studies of projects of varying sizes and complexities, even of different technologies, each with its own economic and environmental advantages and constraints, a list of suitable projects emerges.

The sequence in which these projects might be recommended for development and timing depends on many factors. Some of these are:

- the rate of growth in electric demand;
- the relative need for base-load energy (that electricity which will be needed on a continuous basis 24 hours a day) and peaking electricity (maximum electric demand over a given period, usually one hour);
- the need to balance generation at various points on the province-wide integrated transmission system;
- the relative cost in both economic and environmental terms.

The fact that many projects are being studied does not mean that all the possible projects will be built. It does mean that if the need arises and the projects in question prove feasible, Hydro will be ready to take action to meet the demand.

Hydro's current studies are outlined on these pages to let the people of B.C. know what Hydro believes to be the most likely possibilities for future power development, to indicate roughly which stage studies are at in each case, and to outline the environmental problems that must be considered.

As the projects described are still in the study stage, details may change with time.





The Background

New electric projects are the result of a detailed and careful planning process. It is a process in which engineering, economics, finance, the environment and social concerns are inter-related. The process consumes a great deal of time, contributing in large measure to the long lead-time that is typical of new developments.

In order to plan realistically, we must know the capability of the existing system and have a reasonable insight into British Columbia's expectations for electric requirements in the future.

History

Electricity has formed part of British Columbia's energy pool almost from the province's beginnings. It was produced first in B.C. by a steam plant at Moodyville sawmill, in what is now North Vancouver, in 1882, seven months before Thomas Alva Edison's first central generating station went on line in New York City. First hydroelectricity was generated in B.C. by a 55 kilowatt (kW) plant at Nelson in 1896, within a year of the first major hydroelectric development in North America, at Niagara Falls, New York.

British Columbia's rapid growth in population has been matched by steadily increasing electric generating capacity to meet the needs of its citizens. The province's population was 50 000 when the first plant went on line at Moodyville. By the turn of the century the population had reached 175 000 and 10 years later it was more than 400 000, at which time 23 generating plants — hydro-electric and steam powered — had a total capacity of 50 000 kW. By 1920, with a population of 524 000, the province's installed capacity was more than 165 000 kW, and by 1951 both population and installed electric capacity passed the million mark. In the 20 years from 1953 to 1973, demand for electricity increased by an average of 11 per cent a year in what is now the B.C. Hydro system. Between 1973 and 1980 growth has continued, but at a reduced rate of about 5 per cent yearly on average from 31 March 1973 to 31 March 1980.

By 1961, installed capacity totalled more than 3 million kW and when the Peace River electric project — one of the largest in the world at the time — was announced that year, there were those who said that B.C. would never need its ultimate capacity of 2.4 million kW.

They were wrong. In fact, the Peace project could not be brought into operation fast enough, and during its construction electricity was imported from the United States to meet B.C.'s growing needs. Although in recent years the rate of growth in demand has slackened, it remains a fact that each year more people, industries and businesses require more electricity, and Hydro is called on to supply it.

B.C. Hydro's generating options are confined to those sources which have four basic attributes:

- (a) the source must be available in British Columbia;
- (b) it must have a well-developed technology;
- (c) the cost per installed kilowatt must be competitive with other available sources; and
- (d) it must be acceptable to the provincial government.

Within these parameters, Hydro's future generating options are primarily hydroelectric developments and conventional coal-fired thermal developments.

The Existing System

Electricity supplies less than 20 per cent of B.C.'s total energy — oil products supply about 45 per cent, natural gas 20 per cent and wood waste and coal the rest. About 70 per cent of the electricity is generated by B.C. Hydro, with one privately owned utility, some 30 industrial plants and one city plant generating the remainder.

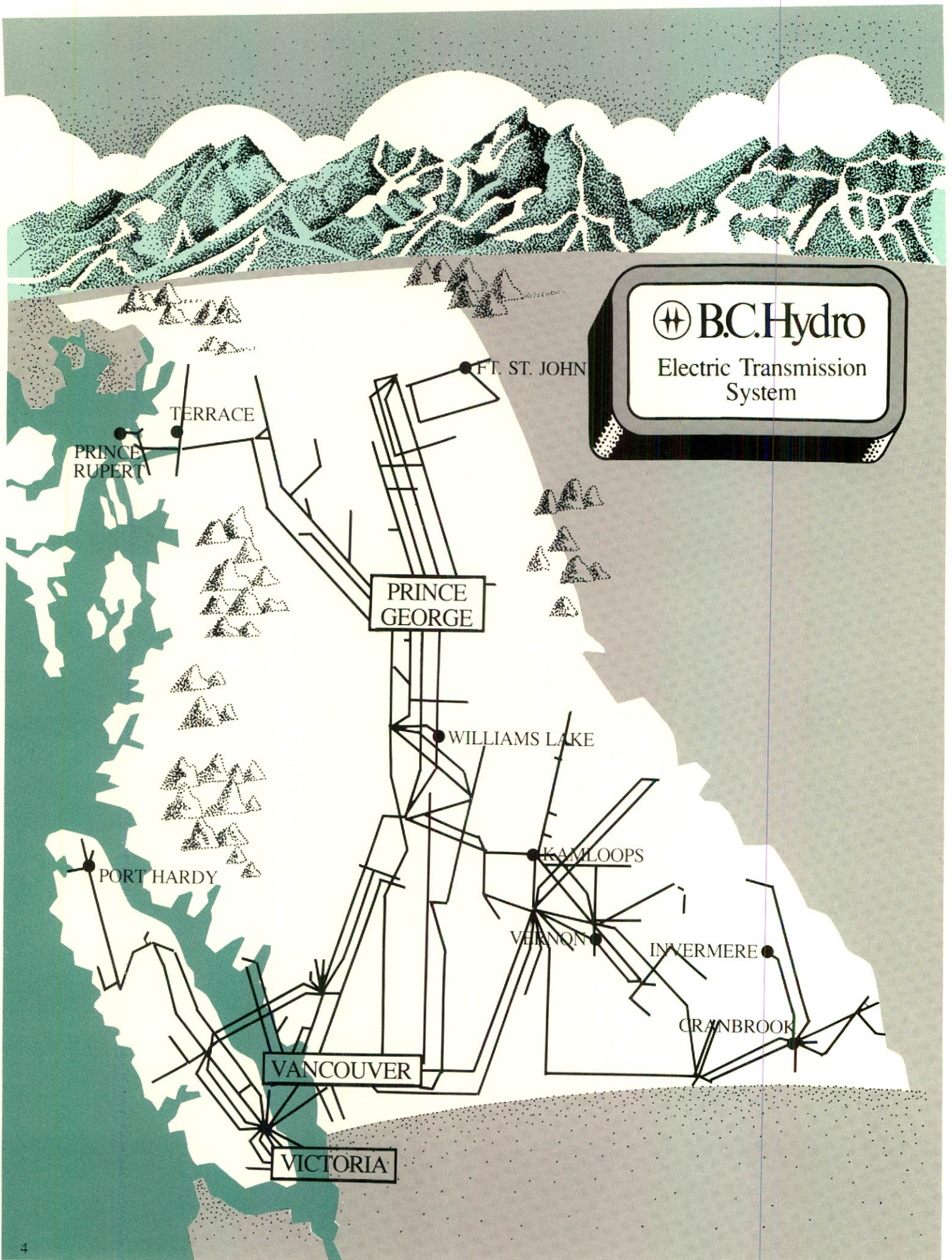
B.C. Hydro

B.C. Hydro came into being in 1962. A crown corporation, it was formed by merging B.C. Electric Company with the B.C. Power Commission. A number of other, smaller utilities have since become part of Hydro, which today is responsible for the overall planning, generation and supply of electricity for more than 90 per cent of the 2.6 million people of British Columbia.



B.C. Hydro

Electric Transmission
System



B.C.Hydro's existing generating system has a total nameplate capacity of some 8.6 million kW. The highest one-hour demand ever recorded to the end of 1980 on Hydro's integrated system — 5.5 million kW — occurred on 5 December 1980. In a hydroelectric system, capacity greater than demand is installed, so economic use can be made of the large amounts of water in the spring runoffs. Extra capacity has other advantages. Generating equipment can be shut down for maintenance and sufficient power is available if a major generating plant is cut off from the system for any reason, such as storm damage to a transmission line.

Generation

Hydroelectric generation accounted for about 7.5 million kW (about 85 per cent) of the installed capacity of B.C.Hydro's system and produced over 98 per cent of all electricity generated by B.C.Hydro in the fiscal year ended 31 March 1981. (On a worldwide basis, hydroelectric generation accounts for only about 2.5 per cent of the total electricity generated.) B.C.Hydro's hydroelectric generating stations range in size from about 700 kW at Clayton Falls near Bella Coola to plants in the order of 2.4 million kW capacity such as G.M. Shrum on the Peace River and Mica on the Columbia River, which together produced almost half Hydro's electricity in the year ended 31 March 1981.

In addition, the Hydro system includes five standby thermal plants with a total capacity of almost 1.2 million kW. Finally, there are stationary and mobile diesel plants and small gas turbine plants of 115 000 kW total capacity serving isolated communities.

Transmission

The bulk of Hydro's generation is connected to an integrated transmission system, a network of transmission lines and substations linking generating stations to one another and to customers, so that electricity can be dispatched as required anywhere within the network. Integration provides balance, flexibility and economy and acts as a safeguard against local equipment failure.

Hydro's integrated system at 31 March 1981 consisted of a total of 15 335 kilometres (km) of in-service transmission lines, in voltages as follows:

500 000 volt lines	4 017 km
360 000 volt lines	330 km
287 000 and	
230 000 volt lines	2 969 km
138 000 volt lines	4 163 km
60 000 volt lines	3 856 km
	15 335 km

An additional total of about 39 430 km of lower-voltage distribution lines carried electricity from 275 substations to customers.

Projects Under Way

The Revelstoke development is Hydro's only major generating project now under construction. The project is scheduled to add 1800 MW to the system by 1984, when four of its ultimate six generating units are due to go in service.

In addition, more than 5300 km of transmission lines are either under construction or planned.

Other Systems

Cominco generates its own electricity for its mining and refinery complex at Trail and at Kimberley, while a subsidiary, West Kootenay Power and Light, supplies portions of the Kootenays and the Okanagan. West Kootenay Power believes that commencing in the early 1980s demand from its customers could exceed its generating capacity. Under the Kootenay Canal agreement, Hydro is required to negotiate sales of electricity to West Kootenay Power and Light and Cominco to meet their deficiencies.

The city of Nelson continues to generate electricity in a plant on the Kootenay River.

Kemano generating station supplies electricity for the Kitimat smelters of the Aluminum Company of Canada, and surplus electricity is sold to B.C.Hydro.

The forest products industry is increasing its generation of electricity by burning hog fuel.

Altogether, these other systems have a total installed capacity of about 2 million kW.





Electric Planning

Load Forecasting

Hydro's planning is designed to ensure that it can fulfill its obligation always to have sufficient electricity available to meet the needs of its British Columbian customers. With growth a reality of British Columbia life, this responsibility entails:

- (a) having a pretty good idea of what that demand will be a decade or more in the future; and
- (b) scheduling additional generating capacity and other facilities to meet that demand.

Not Targets

To this end, therefore, B.C. Hydro annually produces a long-range forecast of gross load requirements. It is important to remember that the forecast figures are estimates used for planning. They are not targets. Hydro does not encourage the demand for energy, but it does have a responsibility to anticipate future need and be ready to meet it when it arises.

Because major new projects can require 10 to 15 years' lead time for planning, design, licensing and construction, it is essential that Hydro's forecast not underestimate future demand, particularly for large industrial complexes which can be built in three to five years. Otherwise, lack of available electricity could impair future economic development, employment and living standards in the province.

B.C. Hydro's 1981/82 load forecast estimates that demand for electricity from the utility's system

will grow at an average annual rate of 5.7 per cent from 1980/81 to 1991/92.

Revised Annually

The forecast reflects Hydro's undertaking to provide electricity to West Kootenay Power and Light starting in 1981/82, when demand from West Kootenay's customers is expected to exceed that utility's generating capacity. Also included is an allowance for sale of electricity to Cominco under the Kootenay Canal agreement starting in 1984/85.

The electric load forecast is revised annually. Trends are continually reviewed to keep Hydro planners aware of changing growth patterns and economic conditions.

Since 1970/71, electric demand on the B.C. Hydro system has grown at an average rate of 6.9 per cent a year, though the rate has slowed in recent years because of economic conditions.

The electric load forecast of 5.7 per cent is Hydro's "best guess" as to how future loads will develop, taking into account expected economic conditions and development and such factors as relative costs of various forms of energy and growing public awareness of the need for energy conservation.

Excluding the requirements of West Kootenay Power and Light from the current projections, Hydro's estimated rate of growth for its own electricity customers would be 5.3 per cent from 1980/81 to 1991/92.

The forecasting process involves estimating sales of electricity, gross energy requirements and peak energy demands for Hydro's electricity customers, currently numbering more than one million, plus expected additional customers over this decade. For administrative purposes, Hydro splits its total service area into five regional divisions which in turn are broken down into 56 districts.

Current Information

The forecasters maintain close contact with large industrial customers to determine their changing requirements for electrical energy. Forecasts of electric needs of these customers are based on the most current information available on the expected operation and expansion plans of existing customers. Allowances for new large industrial customers are made on the basis of enquiries for new services and expansion of existing plants.

Grass roots data collection and analysis by each of the 56 Hydro district managers is taken into account in the development of estimates of future electric requirements. After consultation with local government, business and industry representatives in their respective areas, the district managers provide two-year projections of kilowatt-hour sales by customer class and assessments of short-term commercial and industrial activities for each district.

The local estimates by the district managers are particularly valuable, based as they are upon their knowledge of local people and conditions. Hydro planners must know the energy requirement and the total demand and peak load requirements for each segment of the electric system so that generation, transmission, substation and distribution facilities can be provided to serve each segment adequately.

Combined with the information from local areas are forecasts by corporate economists and independent consultants of general provincial economic trends such as population shifts and economic outlook.

Increasing consideration of the conservation factor is taken in all customer sectors. For example in the most recent forecast significant allowance was made for industrial conservation and improved operating efficiencies.

Load forecasting involves judgement in such wide-ranging areas as future population growth,

development and diversification of the economy, expansion of land use and advances in technology. Projections become progressively more speculative with extension into the future. However, the estimates obtained provide a rational basis for specific short-range planning and general planning for the longer term.

Reduced Growth

The 1981/82 electric projection of 5.7 per cent average annual growth in electric demand to 1991/92 is somewhat less than the 1979/80 growth estimate of 6.2 per cent. The decrease is partially the result of B.C. government policy to promote natural gas for space heating. The proportion of new residential electric heating customers who are expected to install electric heating over the forecast period has been lowered from 55 per cent, assumed in 1979/80, to 37 per cent for this year's probable projection. This reduction includes the basic assumption that natural gas will be available on Vancouver Island

toward the mid-1980s.

Other reasons for this decrease are:

- (a) increased conservation efforts;
- (b) increased motor efficiencies in new appliances;
- (c) reduced space heating demands because of some supplemental solar heating; and
- (d) legislation and incentives concerning insulation in new and existing dwellings.

Hydro plans new plant additions so that the system can meet anticipated requirements. Should growth prove to be slower than forecast, construction of new plants or the addition of new generating units can be delayed.

The Planning Process

Hydro selects a sequence of projects to meet projected electric needs. This sequence, which is reviewed and adjusted annually in the light of new information about projects and revised load forecasts, is known as the "System Plan". Lower cost plants, assuming they can be built on time to meet expected electric demand, are generally scheduled first in the System Plan. Such scheduling is in keeping with Hydro's objective of meeting customers' electric requirements at the lowest practical cost consistent with sound management.

Environmental and engineering studies for potential major projects are conducted in three general steps.



Project Overview

The first phase consists of in-house investigations. As well as covering engineering aspects, the initial studies identify major issues which might affect a project's acceptability. Overview environmental assessments are based on published information and field inspection by Hydro staff. This stage of studies culminates in the preparation of an

internal overview assessment, which indicates whether further, more detailed studies are justified.

Feasibility Studies

If further studies of the proposed project are warranted, the second phase is to investigate the engineering and environmental feasibility of the project. Formal terms of reference of preliminary

environmental studies include practical environmental, engineering and economic views of whether the project can be built. Contact with government agencies also is established. These studies may be shared between in-house staff and consultants. Environmental and socio-economic impacts are weighed along with economic and engineering factors in arriving at a feasibility judgement.

During the feasibility stage, crews may undertake exploratory drilling, site surveys, aerial transmission line route surveys or other related activities. This does not mean that any commitment to proceed with the project has been made.

Preliminary Design Studies

If the results of the feasibility studies are favourable, Hydro may decide to do detailed environmental and preliminary engineering design studies. In this phase the objective is to complete preliminary design studies and gather sufficient information to meet requirements for project licensing, including the preparation of an environmental impact statement and a benefit/cost analysis. During this stage considerable work is done by independent consultants and participation is sought from interested members of the public and from appropriate government agencies.

Overview, feasibility and preliminary design studies can take up to five years. Another two to four years may be required for licensing a proposed project. If a licence is granted, construction could add seven more years.



The Licensing Procedure

Before B.C. Hydro can proceed with construction of a major generation or transmission project, it must obtain various permits and licences, including an Energy Project Certificate from the provincial government.

In the case of generation or transmission projects, some of the provincial statutes which may apply are: the Utilities Commission Act, the Water Act, the Agricultural Land Commission Act, the Heritage Conservation Act, the Park Act and the Environment and Land Use Act. Federal statutes that may apply are: the Navigable Waters Protection Act, the Fisheries Act, the International Rivers Improvement Act, the Canada Water Act, the Indian Act, the Northern Inland Waters Act, the Dominion Water Power Act, the Coal Act, the Coal Mines Regulation Act and the Pollution Control Act.

While for some projects only a few statutes would be applicable, for others, such as the potential hydroelectric development Hydro is studying on Liard River, nearly all would be involved.

The Energy Review Process

Major generation projects and 500 kV lines are subject to advance review and licensing by the provincial government under the Utilities Commission Act. This Act established a formal mechanism for decisions on major energy projects.

The Utilities Commission Act requires that an application for licensing contain detailed information of the project and an analysis of its overall impacts. A public hearing process could be held by the B.C. Utilities Commission which would then report and make recommendations to the Provincial Cabinet.

The public hearing phase of the Energy Review Process will be the focal point for participation by the general public and interested parties.

Between 12 and 18 months may be required to process a project application from the time it is submitted, through review and public hearings to a final decision.

The Cabinet decides upon approval or rejection of the proposal and any appropriate terms and conditions.

Generation Planning

Hydro plans to produce enough electricity to meet customers' requirements under province-wide critical streamflow conditions.

The 44-month critical water period from September 1942 to April 1946 provides a base for Hydro's planning although it does not include the lowest recorded streamflows, which occurred in 1929.

The large Lake Williston reservoir created by the W.A.C. Bennett Dam will play a key role in enabling B.C. Hydro to cope with such low-water years. Because of its size, the lake would not have to be refilled during a single year of below-normal streamflows. Over a period of several consecutive years of below-normal flows, such as the critical period, load requirements could continue to be met by drawing down Lake Williston and supporting the hydroelectric system with thermal and gas-turbine plants. If conditions of the most adverse historic period recur, the lake might be drawn down from its normal full reservoir level to its minimum reservoir level.

As more hydroelectric plants, such as Revelstoke, are added to the B.C. Hydro system the difference in energy output between below-average and above-average streamflow conditions may increase significantly.

During those years when, due to below-average streamflows, hydroelectric capability is less than the demand, B.C. Hydro will have to make up the difference either by using costly natural gas for thermal generation or by purchasing electricity, or both. When streamflows are above average and all reservoirs are full there is excess hydroelectric capability. Rather than spilling the water the excess (or surplus water) can be used to generate electricity for sale in the export market to other utilities which may be short of electricity. Only in the increasingly rare circumstances where a market does not exist would surplus water have to be spilled.

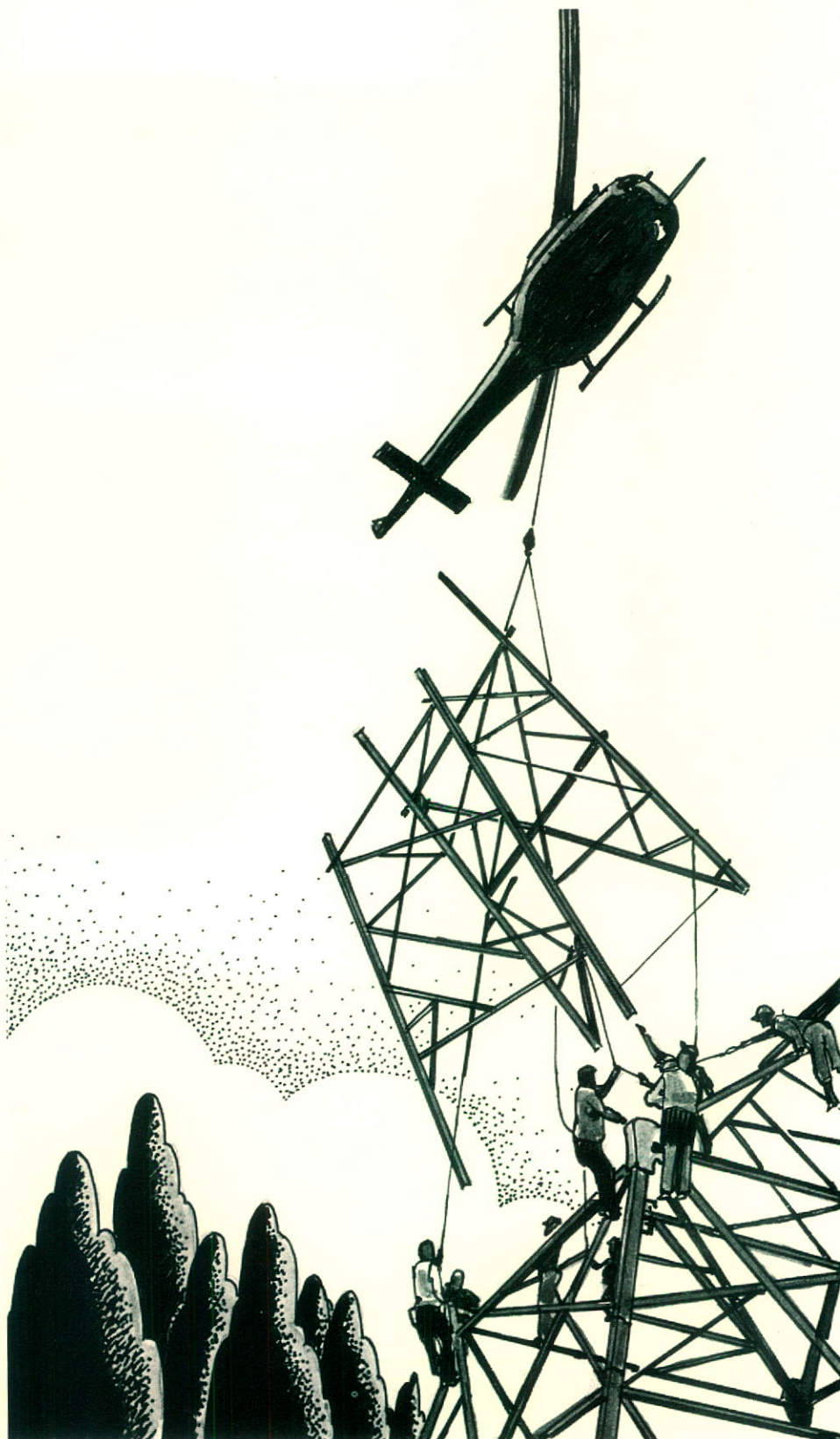
Transmission Planning

There are technical difficulties in transmitting large blocks of electricity. This problem must be kept in mind when generation developments located far from load centres are being considered.

At a given voltage, shorter transmission circuits have smaller losses, fewer outages and proportionally less environmental impact than longer ones. They provide better system stability and voltage regulation and are more economical to construct and maintain. Longer transmission lines, although technically less desirable, are necessary to link more distant generating stations to load centres (northern B.C., for instance, to Vancouver, the Lower Mainland and Vancouver Island). Like most large electric utilities, B.C. Hydro has transmission interconnections with its neighbors (the U.S. Northwest and Alberta) to reduce the impact of major system outages. Such assistance is normally expected for only very brief periods.

Transmission limitations from distant projects can be overcome, although at considerable expense in some instances. Even so, a point will be reached when the geographically limited number of transmission corridors to B.C.'s main load centre in the Lower Mainland are fully occupied.

Existing circuits will then have to be replaced either by double circuit construction or by higher voltage construction. Unless generation close to the load centre is added, the scheduling of future transmission replacement and additions in confined corridors such as the Fraser Canyon will become difficult and expensive.





The Possibilities

B.C. Hydro is currently engaged in studies of a number of potential generating sources.

It is necessary to keep in mind that these projects are so far the subject of study only. In some cases, as with Hat Creek and Site C on the Peace River, the studies are well advanced and applications for energy project certificates have been submitted or are in advanced stages of preparation. In others, such as Cutoff Mountain, the studies so far have been little more than broad surveys based on earlier reports (such as that of the B.C. Energy Board in 1972). Some projects could be brought into service sooner than others. However, selection of particular projects for development and a definite construction timetable depends on such matters as economics, environmental concerns, project feasibility and electric load growth. Should a project prove to be unacceptable for any reason, then the planning studies on another might have to be accelerated. Even a technological breakthrough in a new electric source could alter the eventual sequence of construction.

The Revelstoke project is the last project for which Hydro has had approval to construct. Before there is a decision made to seek approval on any major project which might be added to the B.C. Hydro system any resource, social or environmental problems will have to be evaluated carefully and discussed fully.



Potential Hydroelectric Projects

Peace Site C

Description

Peace Site C, downstream from Peace Canyon Dam and about 5 km from Fort St. John, is one of the most economic new projects available to B.C. Hydro. An energy project certificate application has been submitted to the B.C. government and a public hearing is scheduled for November, 1981.

Power

Capacity 900 MW
Average annual energy 4610 GW.h

Environmental Considerations

Environmental studies on the project have been completed, and an environmental impact statement, summarizing information from environmental studies over the past three years, has been released.

The key concern about the project is the effect it would have on agricultural land in the Lower Peace River Valley. The proposed Site C reservoir, would flood 2600 ha (6,500 acres) of the 21 000 ha (52,000 acres) in the Agricultural Land Reserve in the area. However, only 440 ha (1,100 acres) of the area that would be flooded is currently under cultivation.

Thirty-five households would have to relocate if Site C is developed.

There would be some loss of wildlife, such as moose and deer, due to reduction of habitat. Some species of fish would increase, and others decrease, but a sports fishery could be developed in the reservoir.

Only one major historic site, the Rocky Mountain Fort, would be flooded. Rocky Mountain Portage House, located near the shoreline of the proposed reservoir, also might be affected.

Some other areas where artifacts have been found may be affected to varying degrees by the reservoir or by construction activity.

Kootenay Diversion

Description

Diversion of part of the Kootenay River flow into the Columbia River is allowed under the Columbia River Treaty after 1984.

The treaty allows the diversion of up to 1850 million cubic metres (m^3) of water a year — and about 60 cubic metres per second (m^3/s) average after September 1984 from the Kootenay River near Canal Flats to the headwaters of the Columbia River. The average Kootenay flow at the diversion site is about 88 m^3/s —2780 million m^3 per year.

The diversion would occur via a canal at Canal Flats and would increase the annual output of the Mica and Revelstoke plants on the

Columbia, but would reduce the outputs of the Kootenay Canal and the Cominco and West Kootenay Power and Light plants on the Kootenay River. Plants in the United States also would be affected adversely.

Power

Capacity Nil at site
Average annual energy (downstream in B.C.) 810 GW.h

Environmental Considerations

Protective measures would be required along the Columbia to handle the increased flows and at selected locations on the Kootenay River to prevent excessive lowering of water levels in sensitive areas.

Detailed environmental and engineering studies are under way and should be completed by late 1981.

Control structures on the upper reaches of the Columbia River downstream of Columbia Lake should reduce current high water level problems.

Studies are progressing to find the best way of handling possible sediments that might be brought into Columbia Lake by the diverted water.

Earlier in the project studies possible water temperature reductions in recreational areas were anticipated. More recent studies have indicated, however, that such reduction would be relatively minor.

Aggravation of a serious colour problem in the Kootenay River, caused by the Skookumchuck pulp mill discharging effluent into the river, could result during a prolonged period of minimum river flows, although practical and economic mitigation measures now seem probable.

Murphy Creek

Description

This potential project would be located on the Columbia River about 3 km upstream from Trail and 25 km downstream from Castlegar.

It is being considered as a run-of-the-river development using water for electric generation that has been regulated already by the Mica and Arrow reservoirs.

A pre-feasibility study of the Murphy Creek project was completed in November 1978 and the feasibility studies, started in February 1979, are scheduled for completion in 1981.

Power

Capacity 400 MW
Average annual energy 1870 GW.h

Environmental Considerations

Environmental studies are under way and the results will help Hydro decide whether to seek regulatory approval for the project.

The effects of the project on local recreation and tourism, water quality, fish and aquatic habitats, agriculture, vegetation and forestry, are being investigated.

A significant impact of the project would be the relocation of many households because of reservoir flooding.

Socio-economic implications and possible effects on heritage resources, geology and landforms, hydrology, river morphology and climate, and land uses also are being studied.

Liard

Description

The Liard River enters B.C. from the Yukon Territory near Watson Lake. The river flows in an easterly direction 480 km through B.C. and falls 375 m before entering the Northwest Territories near Fort Liard. The river then flows a further 370 km to Fort Simpson where it enters the Mackenzie River.

The most probable river development scheme involves a two-dam combination. A downstream portion of the river would be harnessed at Beavercrow (Site A), located about 100 km upstream from the B.C.-N.W.T. boundary. Part of the river upstream from the Beavercrow reservoir would be developed at Devils Gorge (Site E), located 25 km downstream from Liard River Hotsprings Provincial Park. Most of the storage capacity would be in the Devils Gorge reservoir for flow regulation. Preliminary studies were carried out in 1979 for an alternative three-dam scheme, which would impound water to a point near Lower Post and would not flood the Liard River Hot Springs. This scheme, however, would produce 30 per cent less electricity than the preferred Devils Gorge-Beavercrow scheme and would be less economical to build and operate.

Energy capability of the Liard River development would be greater than the combined capacity of the two existing Peace River projects (G.M. Shrum and Peace Canyon) and the proposed Site C project.

An engineering feasibility report was prepared in 1980, and environmental and engineering studies are continuing in order to apply for an Energy Project Certificate possibly as early as 1982.

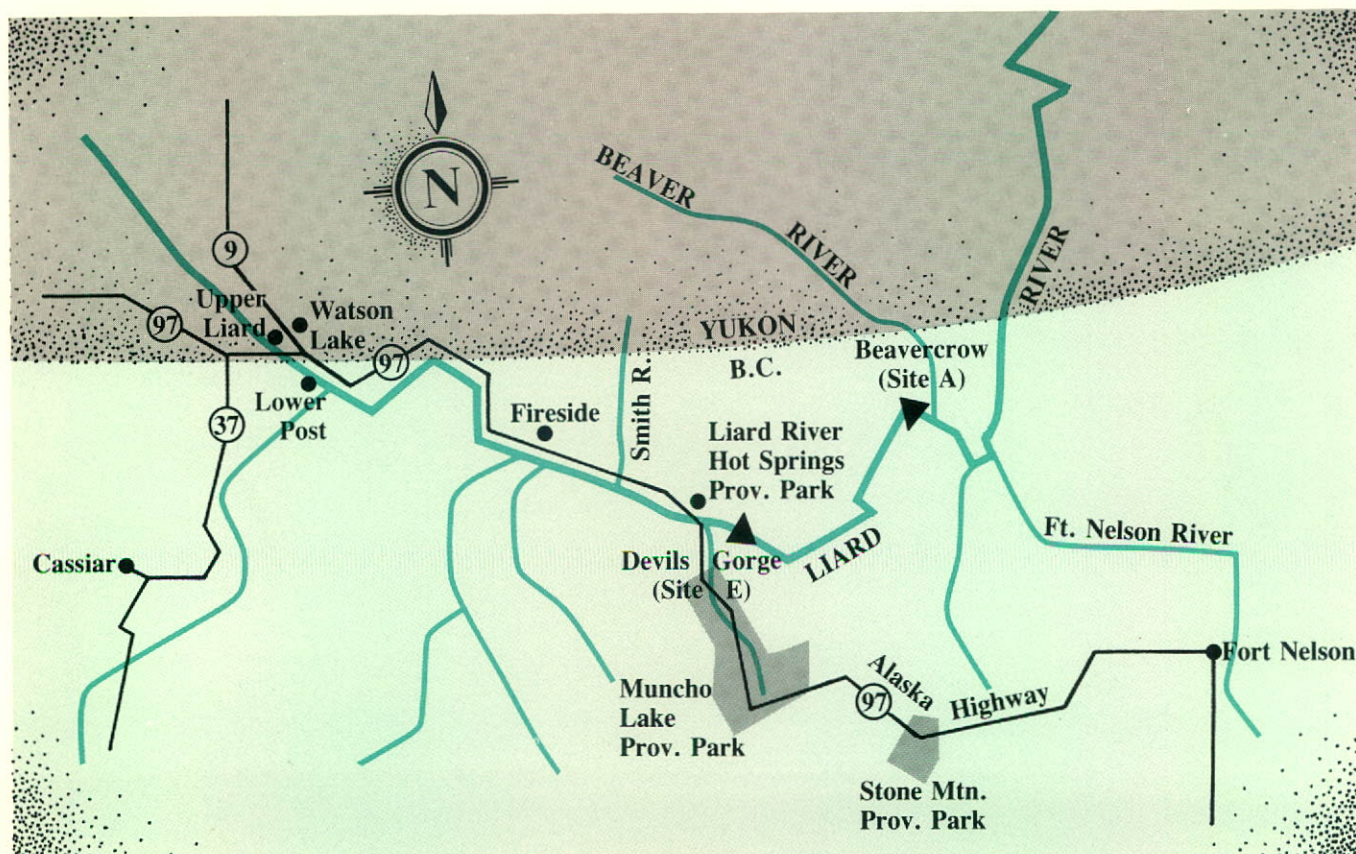
Power

Capacity	4800 MW
Average annual energy	26 000 GW.h

Environmental Considerations

Although Liard River Hot Springs Provincial Park and the Muddy River Indian Reserve would be flooded by the Devils Gorge reservoir, initial studies indicate that environmental and social impacts of the Liard development would not preclude development of this major hydroelectric resource.

Downstream effects of flow regulation could extend as far as the Mackenzie River delta in the Beaufort Sea. The magnitude of downstream changes, the resultant environmental and social impacts and the extent to which these impacts could be mitigated are the subjects of ongoing and future studies.



Stikine-Iskut Development

Description

The Stikine River rises on the Stikine Plateau in northwestern British Columbia, flows a distance of some 500 km to the B.C.-Alaska border and a further 35 km through the Alaska Panhandle to reach the sea near Wrangell, Alaska. The Iskut River is the largest tributary of the Stikine and discharges into it a short distance upstream from the B.C.-Alaska border.

Two Iskut River tributaries of significance to Hydro's studies are More Creek and Forrest Kerr Creek, both having headwaters in the Coast Mountain icefields.

Hydroelectric generation on the Stikine-Iskut system could develop more energy than the G.M. Shrum Generating Station on the Peace River, which last year supplied more than 40 per cent of the province's electricity.

Four hydroelectric sites are being considered for power development: Site Z and Tanzilla on the Stikine, Iskut Canyon on the Iskut and a site on More Creek just upstream of its confluence with the Iskut River. Diversion of the headwaters of Forrest Kerr Creek into the headwaters of More Creek is also proposed and would increase the hydroelectric potential of the More Creek site.

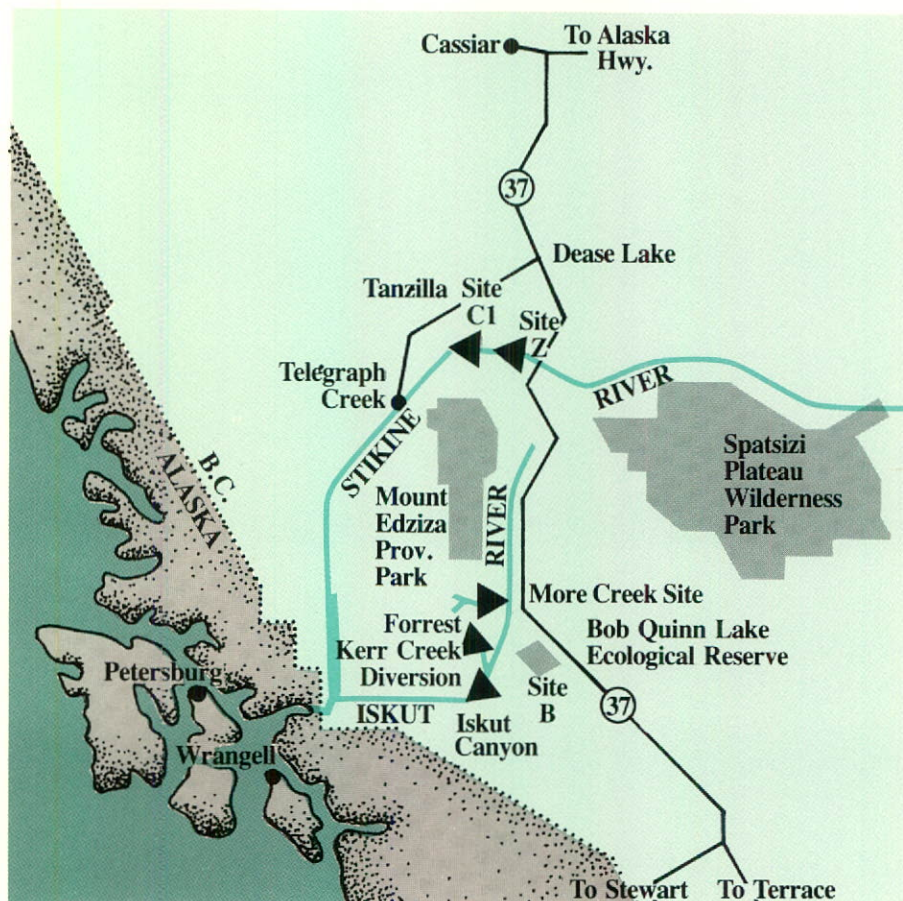
An overview study and two years of engineering and environmental feasibility studies have been completed. Pre-licensing studies are scheduled for completion in early 1982.

Power

Capacity	2765 MW
Average annual energy	15 180 GW.h

Environmental Considerations

The proposed damsites on both the Stikine and Iskut would be above salmon migration runs. Impacts on salmon therefore would be limited to those caused by flow regulation. Studies carried out to date indicate that, without mitigation, there would be some adverse effects on the salmon fishery. However, preliminary assessment suggests that mitigation measures at reasonable cost could protect fish runs from most effects of flow regulation.



Development of the Stikine would reduce the scenic value of the upstream portion of the Grand Canyon, between the Tanzilla powerhouse and the head of the canyon near Highway 37. Two reaches would be partially submerged by the reservoirs and one short reach would be dewatered as a result of bypassing river flows through a tunnel to the downstream powerhouse. However, access would provide greater opportunity for the public to view the Grand Canyon and to take advantage of its recreational potential.

One adverse effect of the development would be to reduce the habitat used by moose and caribou for winter range and for browse. Some mountain goat habitat also would be lost through flooding although there appears to be unused habitat upstream and downstream of the Stikine project to support the displaced animals.

Possible effects of flow regulation on the Stikine estuary within Alaska are being studied.

Homathko River System

The Homathko River flows into Bute Inlet on the southern coast of British Columbia, about 75 km northwest of Powell River.

The most promising development scheme for the Homathko system involves placing several dams on the Homathko River and on a main tributary. Electricity production could be enhanced by diversions from the Taseko and Chilko watersheds. The Chilko watershed is an important sockeye spawning and rearing area and therefore likely would not be included in the Homathko development scheme.

Cutoff Mountain

The Cutoff Mountain hydroelectric site is located north of Hazelton about 15 km upstream from the confluence of the Babine and Skeena rivers. Preliminary engineering and environmental studies of the Cutoff Mountain site were started in 1980.

These studies are to update information published in the 1972 Provincial Power Study report for the B.C. Energy Board.

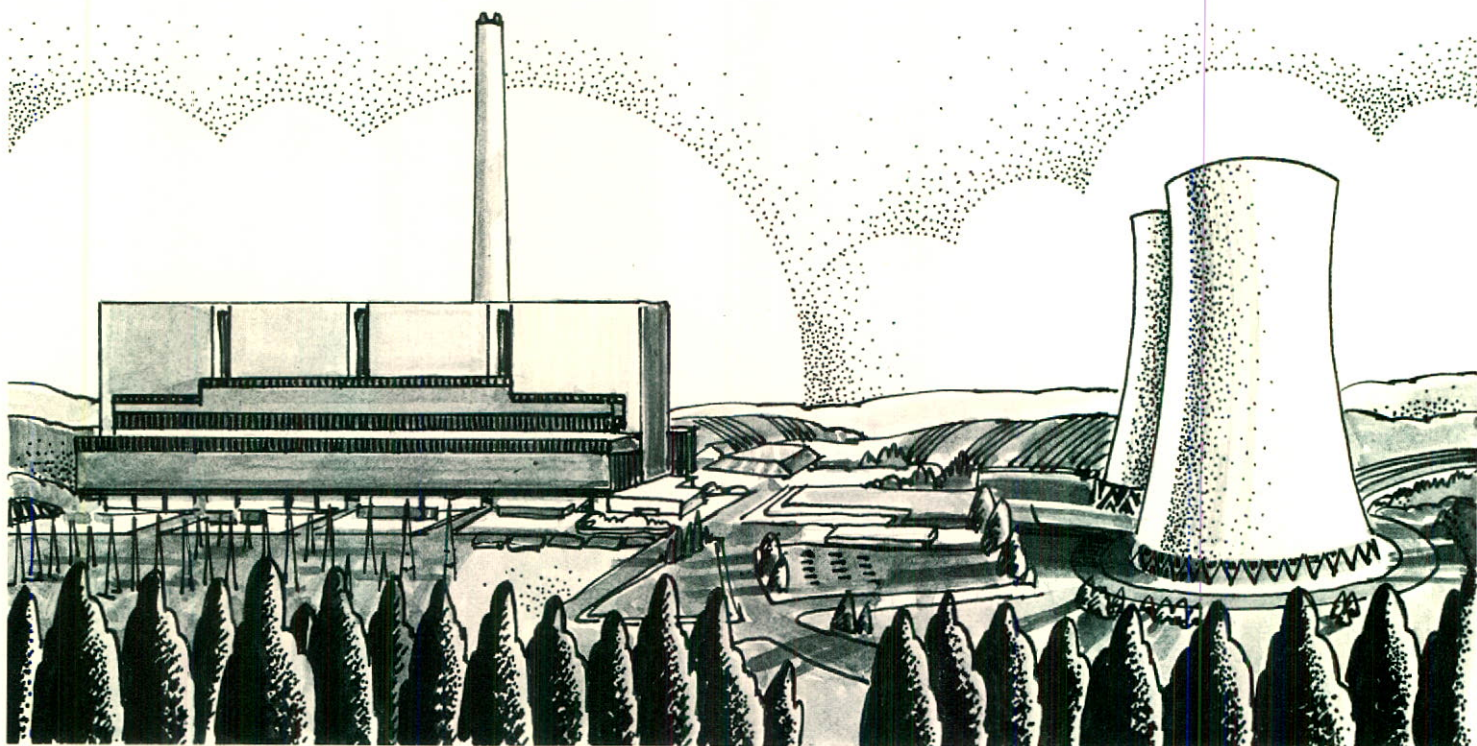
Current studies will involve field trips to the area by Hydro engineers and fish and wildlife biologists plus specialists in vegetation, topography, geology and resource planning. If feasible from an engineering and an environmental point of view, the Cutoff Mountain project would comprise a 260-metre-high dam with an installed capacity of about 1200 MW, capable of generating 6400 GW.h, on average.

McGregor — Lower Canyon

The McGregor River flows into the upper Fraser River east of Prince George and is part of the Pacific watershed. In 1978, studies related to a possible diversion of the McGregor into the Peace River basin were suspended following discovery of fish parasites in the Pacific watershed that had not been identified in the Arctic watershed, of which the Peace River is part. More definitive studies of the parasite problem now are being considered.

A smaller project, however, could be developed at Lower Canyon without diversion. While some studies have been done on this potential project, more are required to determine feasibility.

This scheme would entail a dam about 168 metres high and a powerhouse with a generating capacity of about 360 MW. Average annual energy capability is estimated to be about 1900 GW.h.



Potential Thermal Projects

Hat Creek

Description

The proposed Hat Creek project, located west of Cache Creek, would comprise an open-pit coal mine and coal-fired thermal electric generating station. The earliest that the project could be in service is 1989.

The generating station would be located adjacent to Harry Lake at an elevation of 1410 m. The coal mine supplying the plant would be at the head of Hat Creek Valley about 4 km to the southwest. The project site would occupy an area of less than 2500 ha and would include the proposed mine, powerplant, reservoir and waste disposal areas. Hat and Finney creeks would be diverted around the mine.

At the powerplant the coal would be burned to generate steam which would drive turbine generators. Each of the four boiler-turbine sets or units, scheduled to come into service at one-year intervals, would have a net output of 500 MW. Makeup water for the condenser cooling water system, to replace some water lost by evaporation in the cooling towers, would be provided by a pipeline from the Thompson River.

Preliminary engineering and detailed environmental studies have been completed for the project and an Environmental Impact Statement has been released. An energy project certificate application is being prepared for submission to the B.C. government and the licensing process is expected to provide an opportunity for public comment. The schedule and form of public hearings will be determined by government agencies involved.

Power

Capacity	2000 MW
Average annual energy	11 800 GW.h

Environmental Considerations

Studies indicate that emissions from the powerplant operation would not result in ground level ambient air quality levels that are harmful to human health. There could be, however, potential for slight injury to the most sensitive vegetation species near the project under worst-case conditions. Design plans include a flue-gas desulphurization process called "scrubbing" that will cut sulphur dioxide emissions to about one-half and bring them well within the objectives established by the Pollution Control Board.

Runoff and seepage from mine waste disposal and coal storage areas would be recycled through spray evaporation on waste disposal areas and roads for dust control. Discharge of surface runoff water would occur only following treatment for sediment reduction. No significant impacts are predicted from operation of the Thompson River intake, which is designed to protect migrating salmon.

Progressive revegetation and reclamation programs would be carried out throughout the operating life of the project, resulting in about 65 per cent of the affected lands being available for future productive use.

The Hat Creek project would create more than 2700 construction jobs during the peak construction period and about 1200 operating jobs. This influx of people could have impacts on local housing, services and facilities, as well as upon native Indian bands who live near the development.

East Kootenay

Description

The project would be located 5 km north of Sparwood and 2 km from B.C. Coal (formerly Kaiser Resources) coal preparation plant. The project would use the refuse coals that are by-products of the nearby metallurgical coal mining operation. The coal would be supplied by conveyor belt from the existing refuse coal stockpile and settling lagoons. The coarse refuse would be rewashed, the slurry would be centrifuged, and the beneficiated products would be stored in covered sheds.

Feasibility studies were completed in 1978, and additional meteorological data are being collected. The project is not economically viable when compared with other alternatives but may provide a method of using fuel which is currently discarded.

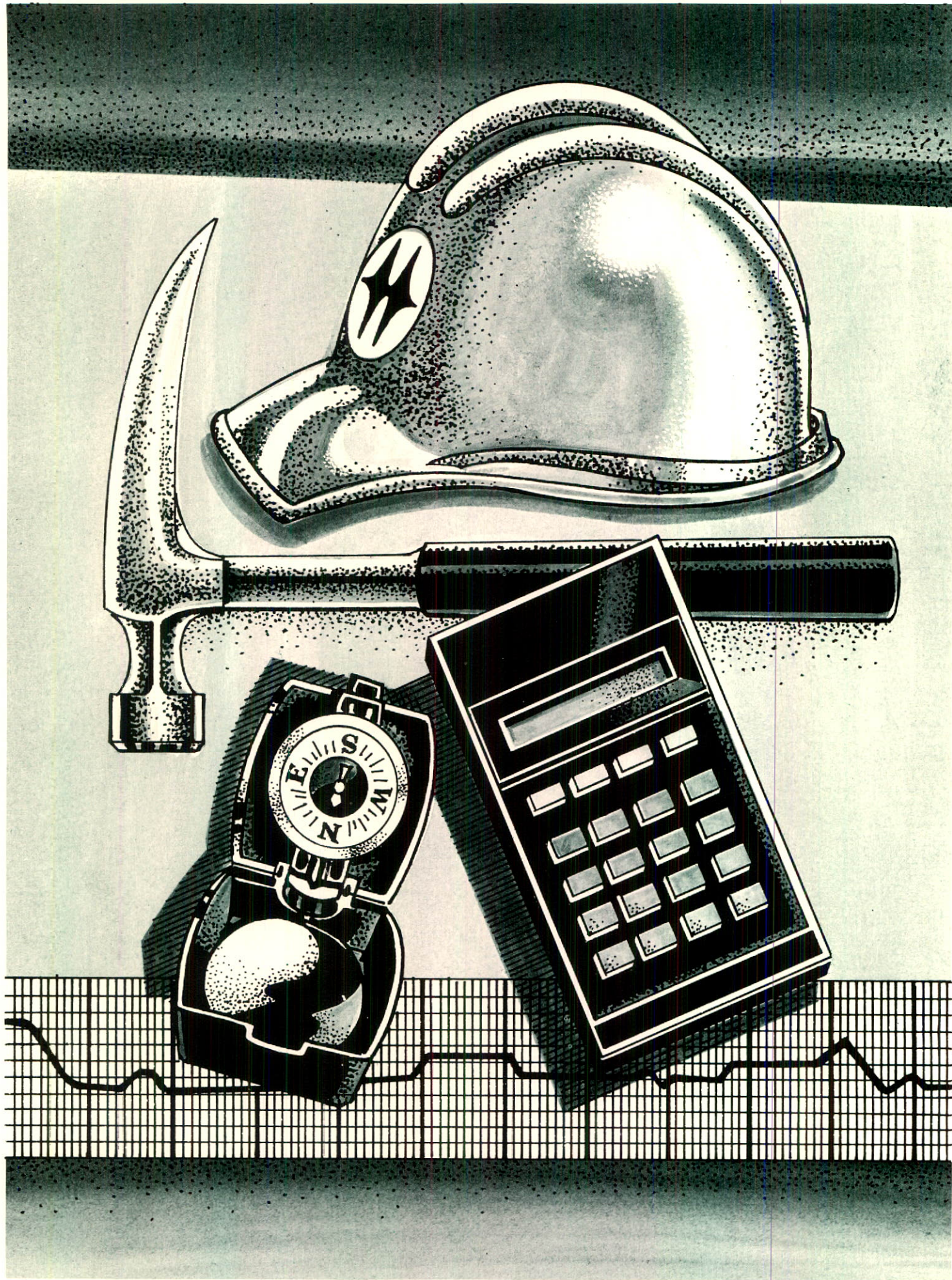
Power

Capacity	600 MW
Average annual energy	3420 GW.h

Environmental Considerations

Emission stagnation problems in the valleys that meet at Sparwood may influence the siting of the thermal plant.

Five local communities have expressed their support for the project. The project is compatible with the existing mining industry in the area, and would add an element of industrial diversification to the area.



Research and Studies

Small Hydroelectric Projects

Hydro is investigating the role of small hydroelectric plants in the 500 kW to 5000 kW range to replace diesel generation in small isolated communities.

Small hydroelectric plants have minimal or no environmental impact and their size, design and capacity can be tailored to local needs.

Although they have a well-developed technology, small hydroelectric developments are considerably more expensive per kW.h produced than large conventional hydroelectric plants.

In this province, however, many isolated communities are served by diesel-fired generators, which, with the escalating price of oil, are becoming increasingly expensive to operate.

Preliminary feasibility studies just completed in the Bella Coola area indicate that some savings could be realized if a 2000 kW (2 MW) hydroelectric plant were constructed there to displace diesel as the main source of electrical supply.

Hydro has embarked on a four-month preliminary design study in the Bella Coola area.

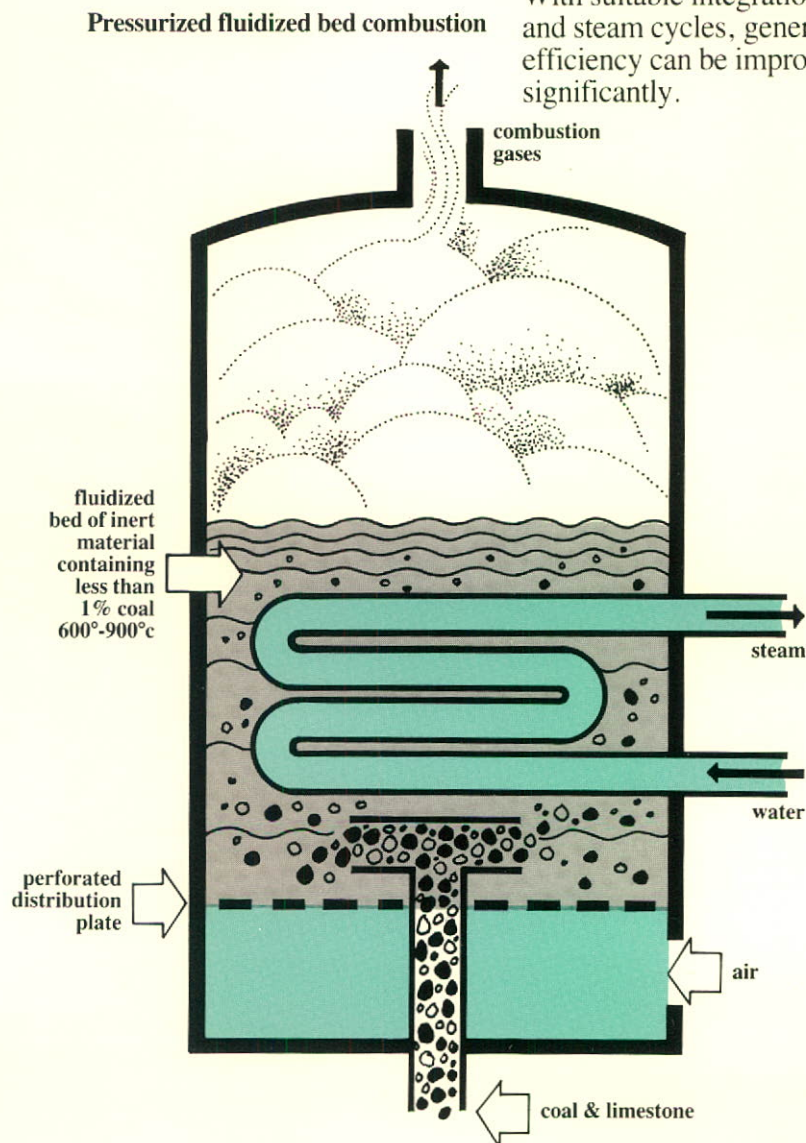
It also is looking at several other isolated B.C. communities for sites where small hydroelectric plants could be beneficial.

Pressurized Fluidized Bed Combustion

Pressurized fluidized bed combustion (PFBC) is a developing technology with particular application to power generation.

The attractions of this combustion technique are the ability to burn low-grade and variable quality fuel efficiently with a high rate of release and transfer of heat and protection of the environment. This in turn offers the prospect of better use of the low-grade coal resource and cheaper and cleaner electricity from coal.

In the PFBC process a selected fuel (coal) burns in a bed or layer of inert material at elevated pressure. The bed is kept in a state of turbulent fluidized motion by an upward flow of air. The resulting combustion gases are expended through a gas turbine for electric generation. In addition, high pressure steam can be generated simultaneously to drive a steam turbine. With suitable integration of the gas and steam cycles, generating efficiency can be improved significantly.

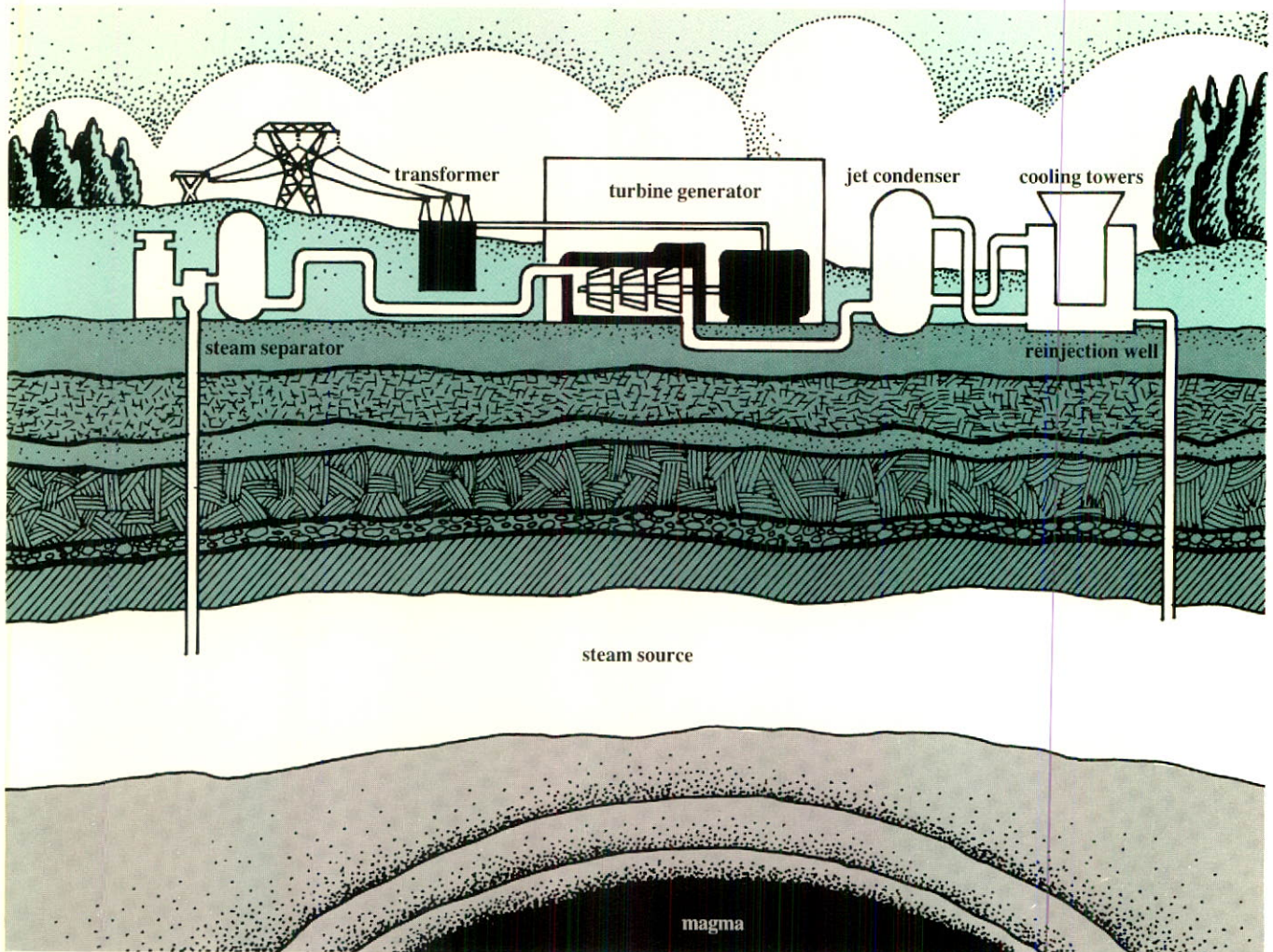


The basic technology of PFBC is available. Further development work is required to proceed with the design of a demonstration plant which would provide the operating experience necessary to allow the construction of a commercial plant. A demonstration plant also could serve as a test installation and a training centre for the engineering and operating staff necessary to run the first commercial plants in Canada.

B.C.Hydro is now studying whether this new technology could be applicable and beneficial for thermal plants in British Columbia. At present only pilot plants at research establishments are in operation.

Geothermal

Geothermal-electric generation is simply the use of hot water and/or steam obtained from the earth's crust to power electric generators. B.C.Hydro is continuing its geothermal exploration program, including geological and geophysical studies in the Meager Creek area about 55 km northwest of Pemberton.



Typical geothermal-electric generating project.

Studies over the past several years by both B.C. Hydro and Energy, Mines and Resources Canada (EMR) have established the existence in the Meager Creek area of a large high-temperature subterranean region on the flanks of a volcano that in geological terms was active recently.

In the fall of 1979, temperatures exceeding 202 degrees Celsius were reached at depths of 357 m on the south side of the mountain. Thermal gradients above regional average also have been discovered on the north side of the mountain.

The drilling results are consistent with other geological and geophysical tests which indicate the presence of a geothermal reservoir.

If the temperature gradient in the north-side hole continues at the same rate, production temperatures would be reached within economic depths which would be sufficient, if combined with adequate porosity pressure and supply of fluid, to provide steam for commercial electric generation.

Surface evaluation of the Meager Mountain volcanic complex, including preliminary drilling, was a prerequisite for the drilling of deep exploratory wells which began during the summer of 1981. Detailed exploration could extend over two or three years and should determine the commercial viability of the reservoir.

Since 1973, Hydro and EMR have spent more than \$3 million in complementary exploration programs at the Meager Mountain complex.

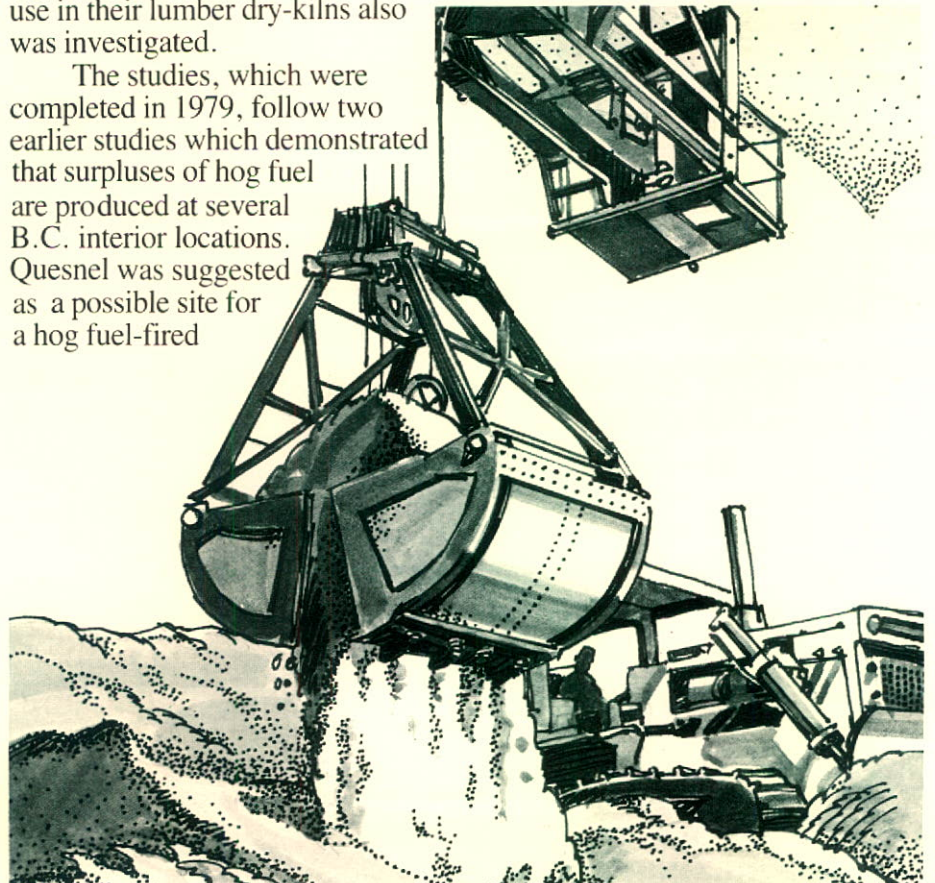
Hog Fuel

Hog fuel is the residue from operations of the forest products industry. It is used, in part, by mills to produce process steam and, in some instances, electric energy for internal use. Not all the hog fuel produced is used for these purposes and there are surpluses which have the potential to produce electricity for use outside the forest products industry.

B.C. Hydro investigated the feasibility of locating at Quesnel a 60 000 kilowatt generating plant to burn hog fuel. The electricity would be fed into the Hydro transmission grid, and the possibility of supplying steam to the local sawmills for use in their lumber dry-kilns also was investigated.

The studies, which were completed in 1979, follow two earlier studies which demonstrated that surpluses of hog fuel are produced at several B.C. interior locations. Quesnel was suggested as a possible site for a hog fuel-fired

plant since the location of five sawmills within a relatively small area there would minimize fuel transportation costs. The studies showed, however, that the cost of electricity from such generation, would be very high when compared with more conventional plants. Moreover a long-term fuel supply could not be guaranteed. Because of the unfavourable economics, no further capital expenditures have been proposed for the project. Nevertheless, there is still considerable government and industry interest in seeing the project proceed and it is possible, given an appropriate subsidy, Hydro could proceed.



Nuclear

B.C. Hydro has, over the years, maintained a "watching brief" on developments with respect to nuclear electricity in general and the Canadian developed CANDU reactor system in particular. In-depth studies of the subject have not been undertaken because of British Columbia's plentiful hydroelectric resources. However, B.C. Hydro is continuing to gather technical and capital cost data on nuclear generation in case it becomes necessary in future.

Nuclear energy is not among the alternative sources of electricity available to Hydro in the 1980s because the lead time for any possible construction of a nuclear plant would be in the range of 13 to 15 years.

The new capital requirement for a nuclear plant is greater than for a conventional thermal plant, although the gap is narrowing. However, by virtue of the relatively small contribution of fuel to the total energy costs over the life of the plant, nuclear plants, once constructed, are very economical to run. They are then similar to hydroelectric projects in being less susceptible to inflation than fossil fuel thermal plants.

The public's major environmental concerns related to nuclear electricity include thermal effects, reactor safety, low-level radiation and the management of long-term nuclear wastes. Studies and operating data from various parts of the world, including Ontario, indicate that the thermal effects resulting from the discharge of cooling water would not be expected to present serious problems; that the probability of major nuclear plant accidents is low; and that man-made radiation levels in the vicinity of operating nuclear plants are much lower than those which occur naturally.

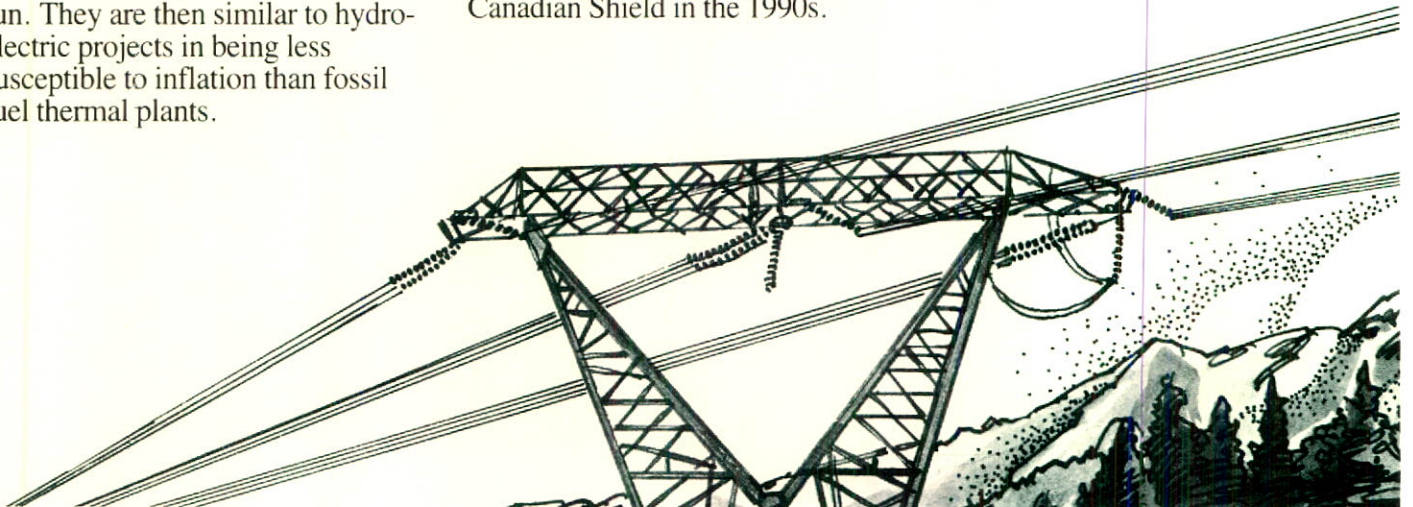
Until it is decided to consign the wastes to permanent disposal, the irradiated fuel is stored securely underwater at the plant site in spent fuel storage bays. A second method, dry storage in concrete canisters, is under test. For permanent disposal, nuclear authorities propose to bury the wastes deep underground in geological formations that have remained stable for hundreds of millions of years. A demonstration repository is planned for the Canadian Shield in the 1990s.

Transmission

Selection of transmission corridors is a lengthy public process involving a balance of technical, economic and environmental concerns. The process also involves meetings with regional and local councils and discussions with concerned individuals and groups before the final route selection is made.

Significant transmission design considerations arise with the potential development of power on the Stikine-Iskut and Liard systems. Consultants are examining possible corridors and transmission voltages from each of these northern projects and potential routes now are under investigation.

Extensive environmental studies have been undertaken and will be released shortly for public review. Studies to date have assessed the technical and environmental constraints of alternative transmission routes associated with generation projects.



Stikine-Iskut

Transmission from the Stikine-Iskut, with long stretches over rugged terrain, would present problems regarding electrical stability and voltage regulation. In addition to local collector lines from the various generating stations, two 500 kilovolt (kV) circuits approximately 500 km long would be required to connect the Stikine-Iskut system to the province-wide integrated system. Existing transmission capacity would have to be augmented between the Prince George area and the Pemberton area, a distance of some 420 km.

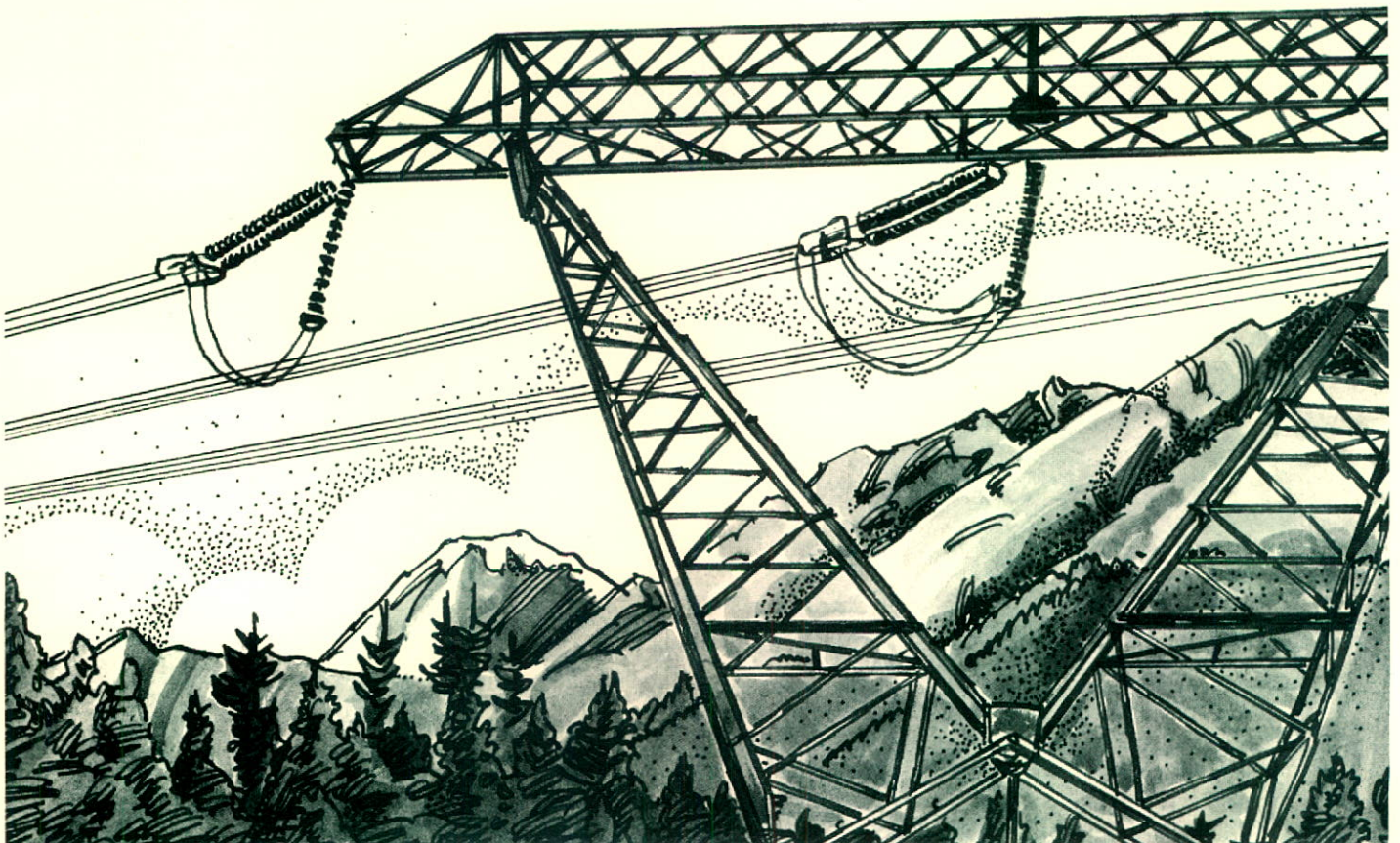
Liard

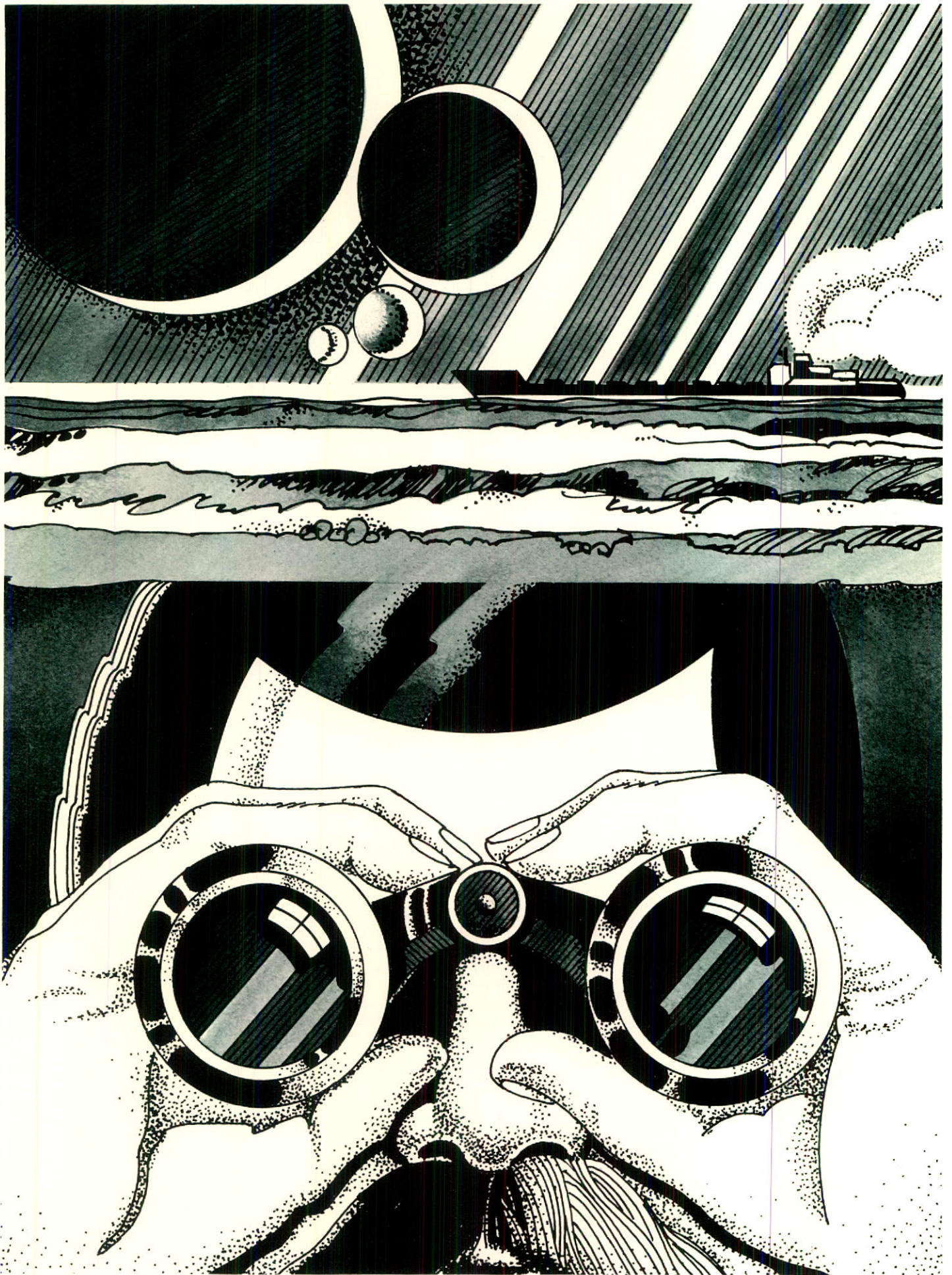
Even greater technical challenges would accompany transmission from the Liard project than those associated with the Stikine-Iskut, due to greater distances and greater power transfers involved.

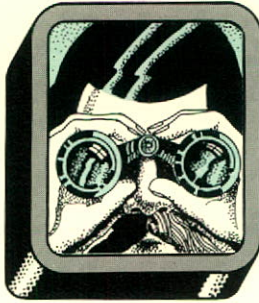
High-voltage transmission would be required to deliver electricity from the Liard River development to the provincial transmission grid system. Alternating current circuits at 800 kV or 1000 kV are being considered. These would be integrated with the provincial grid in the vicinity of Prince George. From this point to the Lower Mainland,

the provincial grid would need reinforcement.

Should the 800 or 1000 kV systems be adopted, B.C. Hydro would be involved for the first time in design and construction of transmission for ac operating voltages above 500 kV. While this would be a first for Hydro, the technology is well established.







Looking Ahead

In the preceding pages, B.C. Hydro has set out the status of its planning for conventional sources to meet the ever-growing demands of British Columbians for more electricity.

Parallel to this process B.C. Hydro is actively promoting conservation, for the wise use of the electricity we have. Conservation is recognized widely as one of the important ways of slowing the growth in demand for energy. Reducing the wasteful use of energy also helps control the cost of energy to the consumer.

B.C. Hydro also is keeping close watch on developments around the world in the so-called "alternative energy" of the sun, wind and sea — research ranging from the depths of the ocean to outer space. Hydro has participated in the design, construction and monitoring of solar heating systems, a technology that is taking its first steps toward significant application. Hydro along with the National Research Council and the provincial Ministry of Energy, Mines and Petroleum Resources has installed an experimental wind turbine generator at Christopher Point on the southern tip of Vancouver Island. Hydro is also engaged with the B.C. forest industry in studies that could lead to substantially increased conversion of wood-wastes to useful energy.

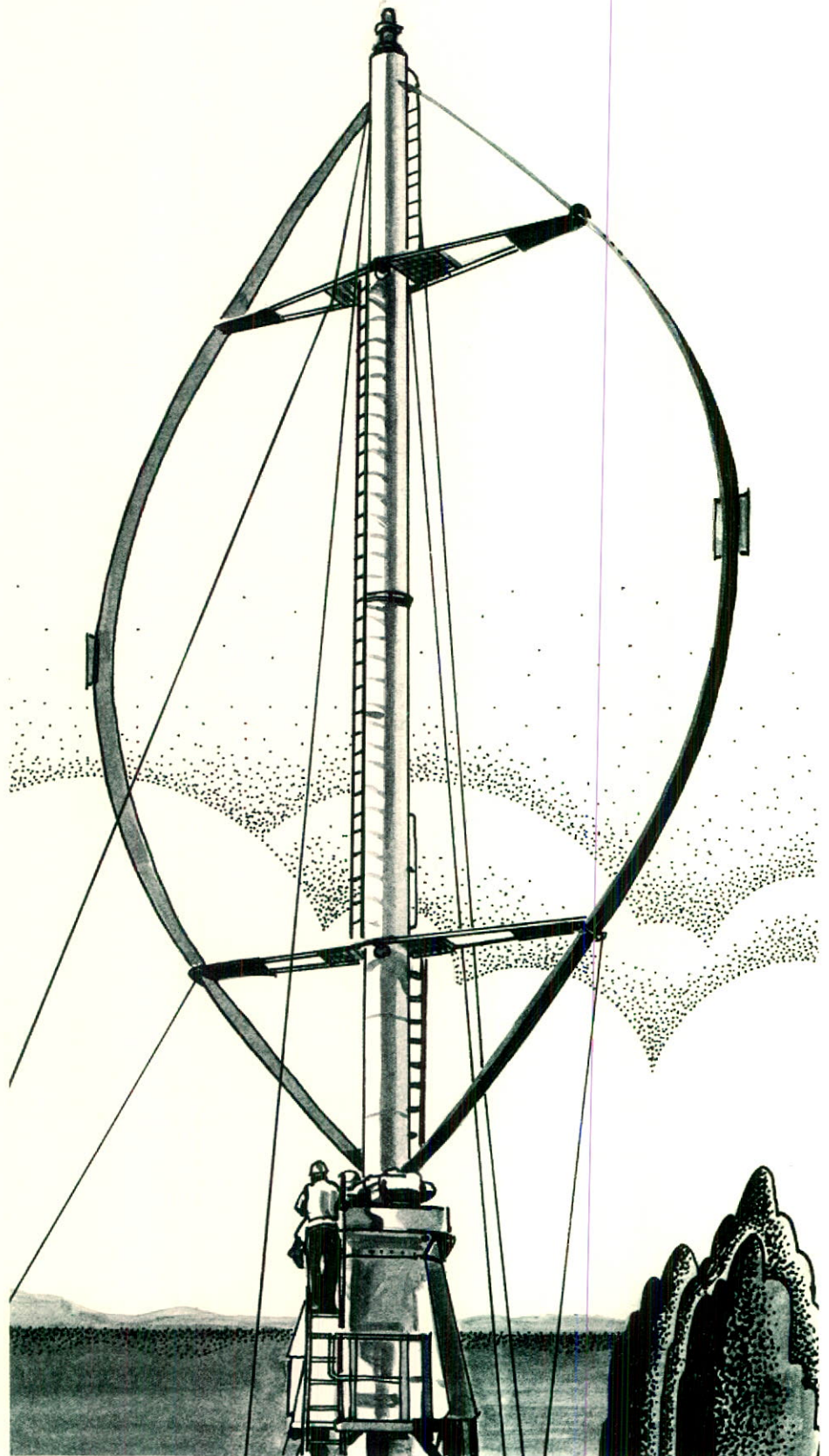
Through its membership in the Canadian Electrical Association, B.C. Hydro is participating in a number of other promising research projects.

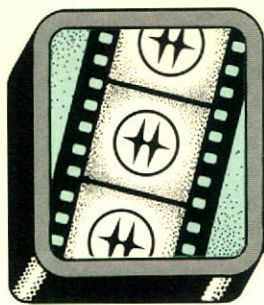
Prospects for the future are exciting. Some of these developing technologies may dramatically affect the energy picture two or three decades from now. Certainly the day will come when it will be essential to employ new technologies to provide the energy our civilization requires. At the moment, however, the alternative energy sources involve technologies that are still being developed or for cost or technical reasons do not appear to be practical for large-scale use.



Hydro's engineers and planners are not overlooking the possibility of a new development or breakthrough in the alternative energy field. Nevertheless, they have to plan today for the electricity British Columbia will need in the next 10 to 15 years. That means using proven technology rather than relying on what we hope science will provide in the future.

In this regard, British Columbia is more fortunate than many other areas in that it possesses plentiful resources of conventional energy — coal and water-power — to bridge the gap between our existing petroleum-based technology and the new technologies that will inevitably arise to replace it. The best choices for bridging that gap have been outlined in this booklet.





B.C. Hydro Films

All bookings should be made through the B.C. Hydro Film Library. Please note that films will be shipped from (or picked up from) the B.C. Government Film Library at 800 Hornby Street, Vancouver, and must be returned there.

The following B.C. Hydro films are available to clubs, churches, schools, colleges, businesses, industry, community groups and associations.

B.C. Today — This film looks at British Columbia through visitors' eyes as a region for investment. A colourful overview, it outlines the major industries — including the electrical system — and how they integrate into the basic economy of the province. 16 mm colour and sound. 22 minutes.

Power and People — For general audiences. The film explains the electrical power system in B.C. It shows how the growth of the system is directly related to the people of the province, and outlines some of the challenges involved in keeping up with the need for new energy. 16 mm colour and sound. 28 minutes.

Energy Below — This is the story of the vast coal deposits in the Hat Creek Valley near Cache Creek and B.C. Hydro's studies regarding potential thermal generation of electricity. Local residents' points-of-view, both for and against the proposed project, are presented. 16 mm colour and sound. 23 minutes.

Kootenay Canal — For general entertainment. A look at the construction of a unique power project, involving a canal to harness the spectacular flood waters of the Kootenay River. An engineering

achievement which, while harnessing needed energy from the river, also protects the environment of beaver, fish, and deer. 16 mm colour and sound. 22 minutes.

Canyon of Destiny — This interesting film depicts, from the beginning, the construction of the giant W.A.C. Bennett Dam on the Peace River. It also discusses the geology of the area, and shows how methods of construction were affected by the geological strata of the site. Very informative. 16 mm colour and sound. 27 minutes.

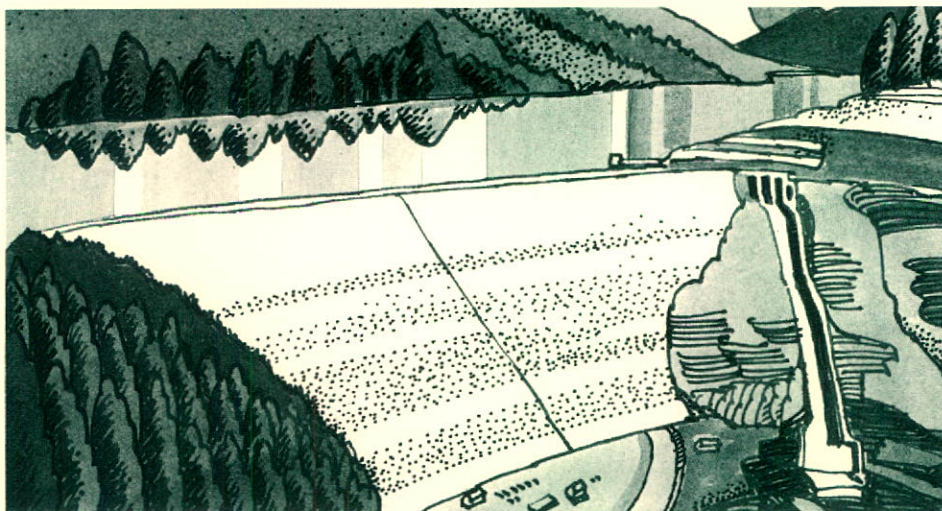
Kokanee of Meadow Creek — This film shows the world's first man-made spawning channels for fresh water fish and explains why the channel was built. It offers spectacular views of the swarming crimson Kokanee in the two-mile-long spawning ground at the north end of Kootenay Lake near Duncan Dam. 16 mm colour and sound. 13 minutes.

Mica — The story of Mica, the largest and most significant project involved in the Columbia River Treaty between the United

States and Canada. The film highlights fundamentals of the Treaty itself. It follows the spectacular construction of the highest earthfill dam, and also one of the largest underground powerhouses, in the Western world. 16 mm colour and sound. 25 minutes.

Energy from the Peace — A balanced description of the proposed Site C project on the Peace River. The film discusses the impacts of the proposed development and mitigation opportunities. It shows how energy from the Peace River can be harnessed a third time to meet the electric needs of the province. 34 minutes.

Today's Options — Bob Fortune conducts a brief but comprehensive survey of electrical energy options open to British Columbia. Solar, wind and biomass are among the possibilities, as well as conventional Hydro and thermal generation. 16 mm colour and sound. 21 minutes.



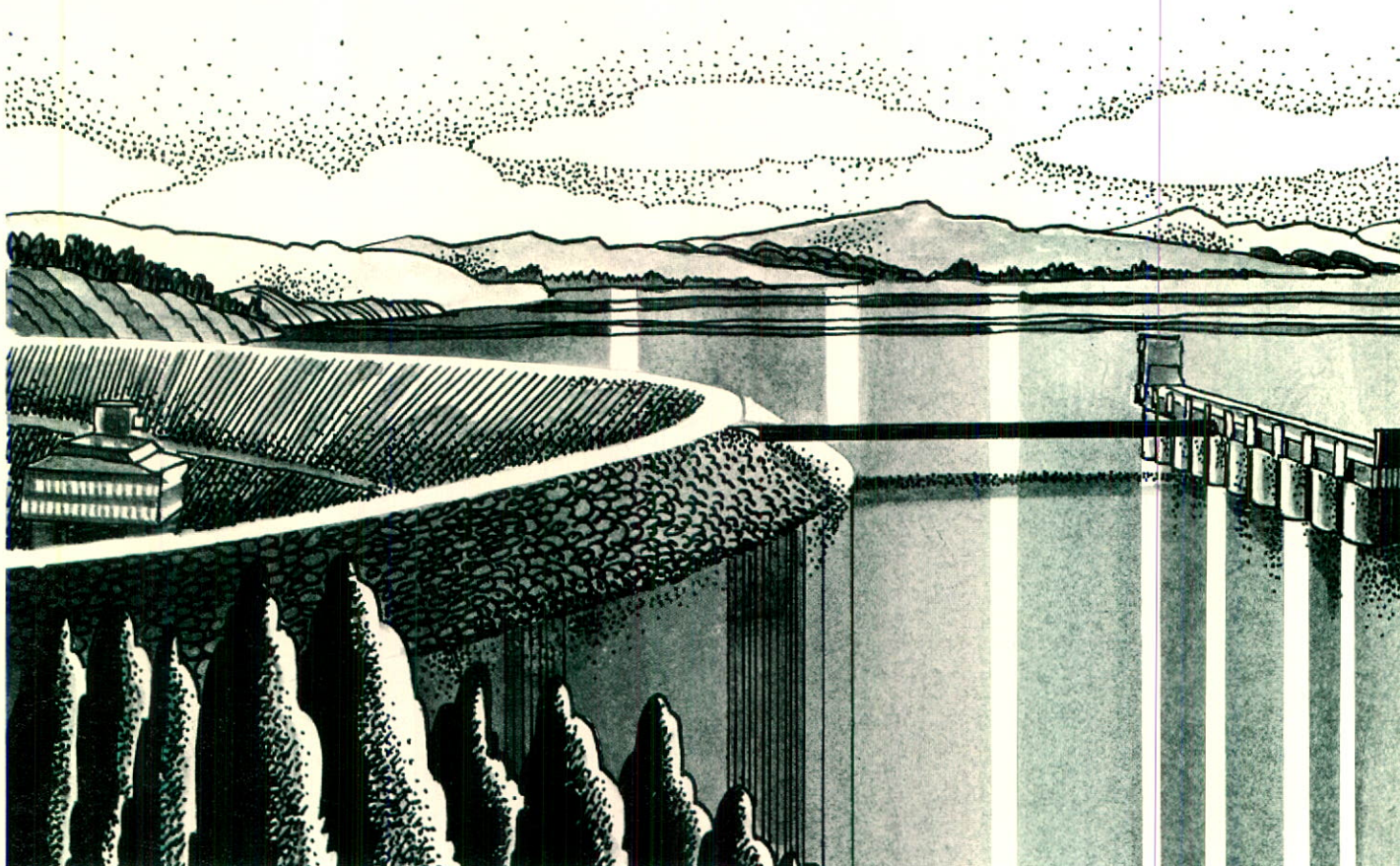
Our Solar Future — The two sides of the solar coin; long-range hopes for large-scale generation potential; and the very practical immediate application of solar energy for space heating, hot water and small-scale electrical output. 16 mm colour and sound. 22 minutes.

Ocean Power — Proposed methods of harnessing the incredible energy of coastal tides, wave action and ocean currents, and the thermal gradient of warm surface water and cold depths. This film has special application to the B.C. coast and features many scenes of familiar areas that have been surveyed for power generation. 16 mm colour and sound. 21 minutes.

Biomass Prospects — Electrical energy from garbage or forest wastes; gas from fermentation; a fascinating study of the possibilities available to us in the conversion of biomass from a refuse problem into an energy source. 16 mm colour and sound. 20 minutes.

The Wind Alternative — Mankind has always been fascinated by the energy of wind. Modern methods of making the wind do useful work may be applied in British Columbia, where we have some of the world's best sites. And the field is open to the invention of better wind machines. 16 mm colour and sound. 20 minutes.

Earth's Furnace — Whatever theory we accept for the formation of our planet, scientists generally agree that the centre of the earth is a molten mass that occasionally vents to the surface and erupts in volcanoes. Less violent action can produce natural steam in large quantities, capable of driving turbines and generating electricity. B.C. is situated on a line of volcanoes, alive and extinct, that stretches from Mexico to Alaska, and Hydro is "getting warm" in drilling tests to tap this source of geothermal energy. 16 mm colour and sound. 22 minutes.



Glossary

ac (alternating current): an electric current that reverses its direction of flow at regularly recurring intervals of time (usually 60 times per second in North America).

Base load: the minimum amount of electricity required by a customer or group of customers over a given period of time. Thus base-loaded generators operate at essentially constant output.

Beneficiated products: coal or other mineral ores which have undergone a process to improve their quality.

Capacity: rated output power of a machine, apparatus or station, measured in watts, kilowatts or horsepower.

Centrifuge: to separate or refine by means of centrifugal force.

Circuit: a system of conductors through which electric current passes.

dc (direct current): an electric current which, under normal conditions, flows in one direction only.

Energy capability: the amount of energy a generating plant can produce in a given time (usually a year). For a hydroelectric plant it relates not only to the size of the generating equipment but also to the availability of water (e.g. with a small amount of water available the plant could be operated at capacity for a short time, then closed down or output greatly reduced so the average level of energy production would be much less than the plant capacity).

Generator: a machine that converts mechanical power into electric power.

Head: difference in height between the water level in the reservoir and the turbine outlet.

km² (square kilometres): a metric unit of area measuring 1000 m by 1000 m.

kV (kilovolts): 1000 volts.

kW (kilowatts): 1000 watts.

kW.h (kilowatt-hour): a unit of work or energy equal to that expended at the rate of one kilowatt for one hour.

Load forecast: an estimate of the power and energy requirements of a utility's customers at a given future time.

m³ (cubic metre): a metric unit of volume (35.3 cubic feet).

m³s (cubic metres per second): a metric measure of flow.

MW (megawatts): 1000 kilowatts, or 1 000 000 watts.

Nameplate capacity: a manufacturer's guaranteed power output rating, measured in watts, kilowatts or horsepower.

Penstock: tube through which water flows from the reservoir to the turbines in a hydroelectric generating station.

Power: the instantaneous rate at which energy is used, measured in watts, kilowatts or horsepower; often used in the broader sense as a synonym for electricity.

Run-of-the-river plant: a hydroelectric generating station operated with the unmodified flow of a river (sometimes regulated by upstream developments) rather than from a storage reservoir of its own; some run-of-the-river projects have limited storage capacity which permits some regulation of streamflow on a daily or weekly basis.

Slurry: semi-fluid mixture of coal fragments and water.

Spillway: a structure, including a chute usually controlled by gates or valves, to discharge excess water from a reservoir.

Streamflow: the quantity of water passing a point in a stream or river in a given period of time.

Thermal gradient: change of temperature with depth or distance.

Turbine: in an electric generating station, a rotary device spun by water, steam or combustion gases and which drives the electric generator.

V (volt): the basic unit of electric force or pressure.

W (watt): the basic unit of electric power, expressing the rate at which electric energy is expended.

